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STATUS OF IMPORTED PARASITES OF THE EUROPEAN CORN BORER

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INTRODUCTION

In planning methods for fighting a destructive pest the possibility of enlisting the aid of its natural enemies, particularly its parasites, is always given careful attention. This method has been used with success in campaigns against several insect pests, and is being given a very thorough test as a part of the efforts to curb the European corn borer.

Extensive studies have been made of native parasites which have attacked the corn borer. In favorable seasons a native egg parasite [1] destroys many eggs of the second generation of corn borers in New England, but this parasite is rarely found in corn-borer egg collections in the Middle West. Other recorded native parasites attacking the corn borer might be termed accidental parasites, as they normally attack a variety of native insects, but at present are practically of no consequence as a help against the corn borer. In the Middle West less than 0.1 per cent, and in New England usually less than 1 per cent, of the borers beyond the egg stage are killed by native parasites.

Since native insect parasites did not attack the corn borer effectively it was extremely important to investigate those parasites which prey especially upon the corn borer in its native European home, particularly in France, Italy, Belgium, and Hungary. As a first step it was necessary to make careful studies of these parasites in the countries mentioned. These studies, which were begun in Europe by the Bureau of Entomology in 1919, soon after the corn borer was discovered in the United States, revealed several kinds of parasites that

[1] *Trichogramma minutum* Riley.

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were helping to reduce the numbers of the pest in that part of the world.

After it was determined that none of these parasites could by any chance become harmful to plants, and that they would not attack each other, they were sent to the United States and liberated in cornfields where the corn borer was most numerous. Special precautions were taken, of course, to prevent the escape of any of their natural enemies (known as hyperparasites) which might be associated with the beneficial parasites.

This circular is intended to inform corn growers and other interested persons of the principal facts regarding these foreign parasite importations.

Previous circulars [2] have explained important methods for reducing existing corn-borer infestations and have discussed briefly the habits of the borer, the results of quarantine and scouting, the situation with respect to existing corn-borer infestation in the several areas of the United States, and similar subjects.

FIG. 1.—One of the imported parasites of the European corn borer, a female of *Eulimneria crassifemur*. Six and two-thirds times natural size

LARGE NUMBERS OF CORN-BORER PARASITES IMPORTED

From early in 1920 to July 11, 1927, over 355,000 foreign parasites of the corn borer were imported from Europe by investigators of the Bureau of Entomology, United States Department of Agriculture.

Twelve different kinds, or species,[3] were included in the shipments. (Fig. 1.) Small preliminary importations of corn-borer parasites were also received from Japan and India during the season of 1927.

All of these were sent to Arlington, Mass., and from there distributed throughout the corn-borer-infested areas of New England and the Middle West.

The details connected with the importation of this beneficial insect material included a very careful study of infested fields in Europe to ascertain the localities in which the desired parasites were present or most numerous. This study required the careful rearing of sample lots of the corn borer collected in its various life stages from infested

[2] WORTHLEY, L. H., and CAFFREY, D. J. TIMELY INFORMATION ABOUT THE EUROPEAN CORN BORER. U. S. Dept. Agr. Misc. Circ. 70, 8 p., illus., 1926.
CAFFREY, D. J., and WORTHLEY, L. H. HOW TO FIGHT THE EUROPEAN CORN BORER THIS FALL. U. S. Dept. Agr. Misc. Circ. 84, 4 p., illus., 1926.
WORTHLEY, L. H., and CAFFREY, D. J. SPREAD AND INFESTATION BY THE EUROPEAN CORN BORER DURING 1926. U. S. Dept. Agr. Misc. Circ. 104, 12 p., illus., 1927.

[3] *Zenillia roscanae* B. and B., *Masicera senilis* Rond., *Eulimneria crassifemur* Thom., *Dioctes punctoria* Roman, *Microbracon brevicornis* Wesm., *Exeristes roborator* Fab., *Microgaster tibialis* Nees, *Phaeogenes planifrons* Wesm., *Apanteles* sp., *Macrocentrus abdominalis* Fab., *Campoplex* sp. A., *Campoplex* sp. B.

fields over a wide area. The presence of many of the parasites which develop inside the corn borer can not be detected at certain stages of their growth without resorting to microscopic examination.

When this preliminary work had shown the places where the parasites were most abundant, laborers were placed in these localities to cut open all infested plants. This exposed the tunnels and showed many dead borers, and near them the cocoons of the parasites that had fed on them. These cocoons were collected for shipment to this country. All the live borers found were also sent to Arlington, in tight metal cans specially handled. These borers commonly contained various kinds of parasites inside their bodies, which months later would complete their feeding, thus killing the corn borers, and ultimately develop into their resting stage and become adults after reaching America.

After the parasite material was collected there remained the difficult task of shipping it to the United States in such a manner that the material would reach its destination in good condition. Extra precautions had to be taken to avoid extremes of heat, cold, moisture, or dryness, both before shipment and while the material was en route. Immediately upon its arrival the material was brought to the corn-borer laboratory at Arlington.

After the parasite material reached Arlington there remained the problem of caring for it in such a manner that the parasites would complete their development to the adult, or parent, stage. Several seasons of experimentation have resulted in the development of methods whereby all of this valuable imported parasite material can be handled so effectively that a very high percentage of the parasites are reared to the adult stage.

After the adult parasites were obtained, special cages were used to insure that the sexes were properly mated before being liberated in fields infested by the corn borer. With this precaution, the females of each species were in condition for effective reproduction even though the sexes became widely separated after liberation.

IMPORTATIONS SUPPLEMENTED BY LABORATORY BREEDING OPERATIONS

Some of the parasite adults were also kept to be used as breeding stock in laboratory operations in which large numbers of the parasites were bred in specially designed cages for liberation in the fields. (Fig. 2.) Since 1921 such breeding operations have been conducted on a very extensive scale at Arlington, Mass., supplemented since 1926 at the Monroe, Mich., corn-borer laboratory of the bureau by similar work with two of the more easily reared species of parasites. This work resulted in the breeding of over 1,535,000 additional parasites. These were added to the number reared directly from importations and were liberated at very carefully selected points in fields infested by the corn borer.

A portion of the parasite material received in the United States was allotted to Canadian entomologists to aid in their fight against the corn borer. Most of the parasites reared from this allotment were liberated directly in the corn-borer-infested fields of southern Ontario, in areas adjacent to the United States. The others were used

as breeding stock to increase the number of parasites, following the methods just mentioned for the United States.

The importation of parasites from Europe and Asia is being continued on an increasing scale to meet the demands of the situation, and the large-scale rearing work in the laboratory will also be continued until all of the suitable kinds of parasites have been given every chance to become established as enemies of the corn borer.

PARASITES LIBERATED AT STRATEGIC POINTS

To give the imported parasites their best chance of establishment, the selections of points for parasite liberation were made only after a careful examination of the entire area infested by the corn borer, so that the parasite, when liberated, would find, as nearly as possible, the conditions existing in its original home in Europe.

Such factors as the following were important considerations in the selection of locations for parasite liberations: The nature, intensity, and distribution of corn-borer infestation; the type of farming prac-

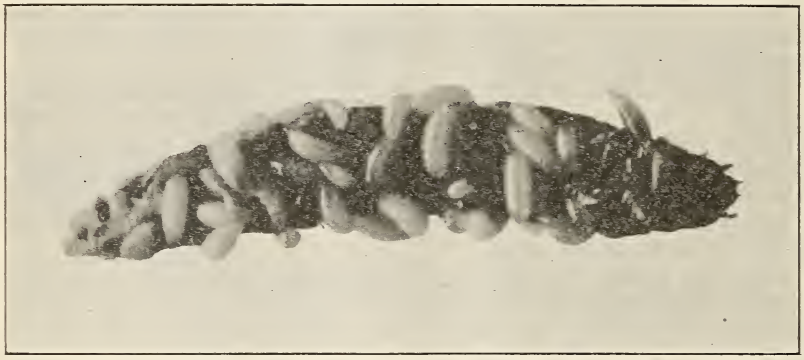

FIG. 2.—The remains of a European corn borer killed by one of the imported parasites (*Microbracon brevicornis*). The maggots of the parasite are shown feeding upon the borer. About four times natural size

tice and cultural methods generally employed; the probable direction and rate of spread of parasites and host; the presence of suitable shelter for parasites during that portion of the year when the adult parasites are exposed to the weather; the presence of varying conditions of soil, moisture, and general topography within an easily accessible distance; the geographical distribution of the liberation sites; and other general conditions which would permit the liberation of large numbers of parasites at each point.

In the vicinity of each liberation point systematic collections and examinations of corn-borer material have been conducted with the object of ascertaining whether each parasite species was becoming established as an enemy of the corn borer in that area. This work also gives definite information as to the rapidity, distance, and direction of spread of the parasites each year. With this information at hand it becomes a simple matter to decide whether additional liberation sites are necessary or whether their establishment would be a waste of funds and effort, as well as a positive disadvantage from the viewpoint of tracing the behavior and spread of the parasites.

If these collections and examinations of borers show that the parasites are spreading and destroying a good percentage of them, it is expected that the continuance of the present importation of parasitic material from Europe and Asia will permit the reinforcement of the established colonies and the selection of additional locations for further colonization.

NUMBERS OF PARASITES LIBERATED IN EACH AREA

Since certain parasite species are bred in large numbers more easily than other species, a report of the actual number of parasites liberated at each selected point or area does not necessarily give a true picture of the present number of parasites in the field. Table 1, however, gives an idea of the liberations made in the several areas up to July 11, 1927.

TABLE 1.—*Total corn-borer parasite liberations to July 11, 1927* [1]

	Michigan			Ohio		
	Richmond	Monroe	Erie	Bono	Sandusky	Mentor
Zenillia roseanae		3,278			565	
Masicera senilis		318			175	
Eulimneria crassifemur	[3] 2,195	2,582	2,777	3,252	5,119	2,720
Dioctes punctoria			207			
Microbracon brevicornis	21,369	20,043	23,700	40,770	117,376	461
Exeristes roborator	5,799	[2] 9,921	[2] 11,099	[2] 16,150	[2] 13,734	9,605
Microgaster tibialis	5,711	2,275	8,631	[2] 16,012	12,579	12,575
Phaeogenes planifrons			1,161			
Apanteles sp		3,625			2,025	
Total	35,074	42,042	47,575	76,184	151,573	25,361

	New York (Silver Creek)	Pennsylvania	Indiana (St. Joe)	Illinois (Sherburnville)	New England	Total
Zenillia roseanae					43,525	47,368
Masicera senilis					[2] 7,966	8,399
Eulimneria crassifemur					[2] 12,845	31,490
Dioctes punctoria					[2] 7,584	7,791
Microbracon brevicornis	52,393	18,230	11,000	3,635	1,082,270	1,391,247
Exeristes roborator	[2] 12,943	4,433	3,057	362	[2] 54,957	142,060
Microgaster tibialis	144				[2] 55,214	113,141
Phaeogenes planifrons					[2] 8,602	9,763
Apanteles sp					33,938	39,588
Macrocentrus abdominalis					6,678	6,678
Campoplex sp. A					325	325
Campoplex sp. B					230	230
Total	65,480	22,663	14,057	3,997	1,314,074	1,798,080

[1] Canadian liberations not shown. [2] Field recoveries made. [3] Recovery doubtful.

It will be seen that nine different kinds or species of imported parasites of the corn borer have been liberated in Michigan, comprising 124,691 individuals. Seven species, totaling 253,118 individuals, have been placed in infested cornfields in Ohio; and at St. Joe, Ind., 14,057 imported parasites of two species have been liberated.

Two species were also placed at North East and Mill Creek, Pa., consisting of 22,663 individuals; and at Silver Creek, N. Y. (Hanover Township), and on the Cattaraugus Indian Reservation, in the same State, a total of 65,480 imported parasites have been liberated,

consisting of three different species. In the isolated corn-borer infestation near Sherburnville, Ill., two species of imported parasites were liberated, comprising 3,997 individuals.

Twelve species of imported corn-borer parasites have been liberated in the infested area of New England, comprising 1,314,074 individuals. These were liberated in eight separate locations in Massachusetts, as follows: Arlington, Cambridge, Medford, Saugus, Malden, Revere, Quincy, and Chatham. In connection with the New England liberations it should be emphasized that extensive colonizations of imported parasites of the corn borer had been made in that area before the degree of infestation by the borer in other parts warranted the liberations of parasites. In addition to this, certain fragile species of parasites could not be shipped to the more western areas until methods had been devised for successfully transporting them to distant points.

TOTAL LIBERATIONS OF IMPORTED PARASITES

In the United States a total of 1,798,080 imported parasites of the corn borer have been liberated in infested fields. The actual numbers of each of the 12 species are shown in the last column of Table 1.

SIX SPECIES OF IMPORTED PARASITES RECOVERED IN THIS COUNTRY

Systematic collections and field examinations in the vicinity of the locations where the imported corn-borer parasites were liberated have resulted in the recovery of six species of these parasites under circumstances which showed that these species have become established in the United States and that they are now at work preying upon the corn borer. In the Middle West two species were thus recovered up to July 11, 1927, with a doubtful record of a third species, while similar work in New England has led to the recovery of six species.

In order to verify this it was necessary to develop special methods and cages for collecting and observing corn-borer-infested material. Part of this material was placed in large screened cages, or in screened compartments, in bulk, to await the emergence of the parasites, and of course many thousands of borers have been isolated in small glass-vial cages for detailed observation and study to be certain that the parasites recovered were actually at work upon the corn borer.

In the Middle West these recoveries were made at Monroe, Erie, and Richmond, Mich., and Bono and Sandusky, Ohio. Recoveries were also made at Silver Creek (Hanover Township), N. Y. In New England the recoveries have been made at various points over a wide area.

PARASITE CONSERVATION CAGES

In order to aid in the conservation, recovery, and spread of the imported parasites of the corn borer, 10 large cages have been built at various points. Three cages are located in the vicinity of the parasite-liberation points in Michigan, three in Ohio, two in Pennsylvania, and two in western New York.

These cages (fig. 3) are covered with copper screen having 18 meshes to an inch. They are 99 feet square and 7 feet high. Each

cage is large enough to provide for the shocking of all the cornstalks grown on from 10 to 12 acres of infested fields. All parasites emerging from these cornstalks fly to the screen sides of the cage where they are collected to be liberated again in strategic places within the area infested by the corn borer.

The tight construction of the cages and their covering of fine-mesh copper screen prevent the escape of the corn-borer moths which emerge from the cornstalks within the cage.

No imported parasites are liberated within these conservation cages. The principal use of the cage is to hold large quantities of cornstalks infested by the corn borer, together with their contained parasites, the progeny of the imported ones, which would otherwise be destroyed during the clean-up operations.

In addition to their use in connection with these parasites the conservation cages provide an effective method of adding to the present knowledge concerning the status of the native parasites of the corn borer.

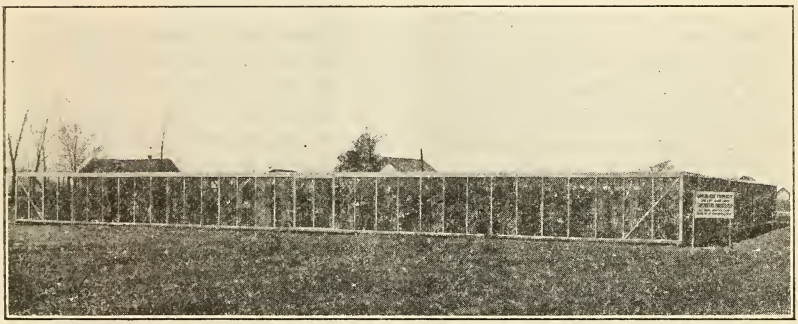

FIG. 3.—One of the parasite conservation cages erected to aid in the conservation, recovery, and spread of the imported parasites of the European corn borer

PARASITES CAN NOT HARM PLANTS

The fact should be understood that none of the parasites which have been imported to aid in the fight against the corn borer can, by any chance, become harmful to plant growth.

PARASITES ALONE UNABLE TO CONTROL CORN BORER

Although efforts are being made to import, breed, and establish parasites of the corn borer in American areas infested by the corn borer, it is by no means certain that they will prove to be effective aids in controlling the pest. Judging from the experience with similar parasites imported to aid in the fight against other foreign plant pests several years may elapse, even with the best of success, before any important effect can be expected.

In the meantime every effort should be made to control the corn borer by following clean farm practices and clean cultural methods leading to the destruction or use of all corn residues of the previous year before the corn borers emerge from them as moths in the spring. The details of such practices have been discussed in previous circulars and in other bulletins of the Department of Agriculture.

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October 10, 1927

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